TECHNICAL MANUAL

MODEL 268-1-A-V-T-M-ET-PL

FREQUENCY CONVERTER

POWER FREQUENCY CONVERTERS

SOLID-STATE INVERTERS

UPS APPLICATIONS

SUNVERTERS®

abacus controls inc.

80 READINGTON ROAD
SOMERVILLE, NJ 08876
(201) 526-6010

APPLICATION		REVISIONS			
NEXT ASSY	USED ON	LTR	DESCRIPTION	DATE	APPROVED

TECHNICAL MANUAL

MODEL 268-1-A-V-T-M-ET-PL

FREQUENCY CONVERTER

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS ± 1/64 DECIMALS ± .005 ANGLES ± 1/2°	CONTRACT NO.	abacus controls inc.	80 READINGTON ROAD SOMERVILLE, N. J. 08876
	DRAWN 7-27-79 jr		
	CHECKED	TECHNICAL MANUAL MODEL 268-1-A-V-T-M-ET-PL FREQUENCY CONVERTER	
MATERIAL	ENGINEER R.P. Tomko		
FINISH	APPROVAL	SIZE A / 54241 / 10523	
		SCALE	SHEET

SECTION 1. GENERAL DESCRIPTION

The Model 268-1-A-V-T-M-ET-PL Frequency Converter is a solid state electronic device that converts three phase 60Hz power into regulated three phase 400Hz power at a load rating of 6000 Volt-Amperes. Drawing 20785, the Outline Drawing, shows dimensions, terminations, control, and monitor features and installation clearances.

This equipment is built into a free-standing cabinet that moves on casters. Options included are overtemperature protection, extended temperature range (-25°C to +55°C), phase lock capability, ammeter with phase selector switch, elapsed time meter, and voltmeter with phase selector switch.

Most of the electronic circuitry is on nine printed circuit modules and twelve output power modules. Power modules are interchangeable; printed circuit modules are notched and keyed to prevent incorrect insertion.

SECTION 2. INSTALLATION

The Outline/Installation drawing for the 268-1-A-V-T-M-ET-PL Frequency Converter is drawing 20785. There are no particular mechanical installation requirements other than observing the indicated airflow clearances.

Electrical installation is at terminal boards which are accessible by opening the rear door of the unit. Input 60Hz power is connected at terminal block TB1, with terminal assignments as follows:

TB1-1	208V, 60Hz Input, ØA
TB1-2	208V, 60Hz Input, ØB
TB1-3	208V, 60Hz Input, ØC
TB1-4	208V Neutral

The 400Hz output of the unit is at TB2:

TB2-1	208V, 400Hz Output, ØA
TB2-2	208V, 400Hz Output, ØB
TB2-3	208V, 400Hz Output, ØC
TB2-4	208V Neutral

On the unit equipped with phase lock option, the 115V, 350-450VAC reference signal may be connected at TB3:

TB3-1	115V, 350-450Hz
TB3-2	115V, 350-450Hz Return

SECTION 3. OPERATING INSTRUCTIONS

3.1 Make sure that all installation steps have been correctly performed.

3.2 Apply power by turning the input power switch "ON". Observe that the cooling fans are turning, (audible), and that the voltmeter has an indication.

3.3 If phase lock to an external source is needed, set the PHASE LOCK switch to the ON position. Note the PHASE LOCK on indicator lamp.

3.4 Rotate VOLTAGE SELECT switch to monitor all three output phases.

3.5 Rotate CURRENT SELECT switch to monitor output current in each phase.

NOTE

Voltage and current monitors operate only when the frequency converter is ON.

CAUTION

DO NOT remove any of the printed circuit modules while the equipment is in operation.

CAUTION

DO NOT use or connect any grounded electronic test equipment to any point when troubleshooting or making measurements.

3.6 To remove the equipment from operation, turn the input switch off.

SECTION 4. THEORY OF OPERATION

A schematic diagram of Model 268-1-A-V-T-M-ET-PL Frequency Converter appears on drawing 40466. Supporting schematics for the system modules are described below in Sections 4.1 through 4.5. With reference to drawing 40466, the input voltage is applied to autotransformer T1, full wave rectified by rectifiers CR1 through CR6, and filtered by inductor L1 and capacitors C1 through C5. Resistors R1 and R2 provide a discharge path for the capacitors when primary power is removed.

Power Supply Module A19 provides a regulated 5V supply for logic circuitry and an unregulated -12V supply for biasing. Low voltage cutoff, high voltage cutoff, and time delay at turn on functions prevent the 5V regulated supply from being applied to driver modules A13 through A18 unless the three conditions of voltage and time delay are met. With no 5V applied to the driver modules, the output of the Frequency Converter is off.

Logic & Control Module A10 generates 3 phase signals, provides frequency control, and through digital synthesis, regulates the output line voltage through feedback transformer T10. Current limit overrides voltage regulation for overload conditions. This is accomplished through current transformers T5, T6, and T7.

The output patterns from Logic & Control Module A20 at pins N, P, and R are shown on drawing 20580. These output patterns are converted to an upper and lower drive signal and amplified in Driver Modules A13 through A18. The outputs from these modules are connected in a closed delta to output transformers T2, T3, and T4. Output filtering is by means of the leakage inductance on transformers T2, T3 and T4 working with capacitors C6, C7, and C8.

4.1 Power Supply Module - The schematic diagram of the power supply module is drawing 20734. Integrated circuit IC1 is located off-card, (see drawing 40466), and is a 5 ampere +5 volt regulator.

On the printed circuit module, a quad comparator, IC1, prevents the regulated 5V from being delivered to the driver modules through transistor Q1 whenever the 5V is low (comparator terminals 8, 9, and 14); when the time delay is not satisifed (comparator terminals 4, 5, and 2); or when the input voltage is too high (comparator terminals 6,

7, and 12). When comparator terminal 14 is low in voltage, transistor Q2 conducts and causes transistor Q1 to deliver the 5V to the Driver Modules.

4.2 Logic & Control Module - The schematic diagram for the Logic & Control Module is drawing 40261. Voltage feedback signal enters the module through diodes CR1 through CR6 and is rectified and filtered for comparison with the reference signal. Voltage adjust R4 establishes the regulation point for the output voltage. Voltage control is accomplished by lowering the voltage to the voltage controlled oscillator (VCO), which is located on two comparators on IC2 (terminals 4, 5, 12, and 10, 9, 7). When the collector at terminal 1 of IC1 draws more current through resistor R10, output voltage is reduced.

Slow turn on is accomplished by transistor Q1, which is energized during turn on by the time delay circuit in the Power Supply Module through resistor R1. When Q1 conducts, a "high voltage" signal is applied to the integrator amplifier IC1. When Q1 ceases conducting, a slow turn on occurs as capacitor C5 discharges.

Frequency control is accomplished at IC6 terminals 10, 11, and 13. Basic frequency of the square wave oscillator is 230,400Hz. This frequency is set by R3 and the front panel control. Output of the basic frequency oscillator is divided by 3 in IC7, then it is applied to binary counter IC4, from which one output is utilized. The QC "divide by 16" output is used to synchronize the VCO through IC6 terminals 6, 7, and 1; this is a one shot multivibrator that applies a 1 microsecond pulse to the "clear" input of the second half of IC4 and to the output of the VCO through transistor Q2. The QD output frequency is 4800Hz, and its pulse width of 208.2 microseconds is equivalent to 30 electrical degrees at 400Hz. The VCO is reset every 30 electrical degrees.

Output QD from section 1 of IC4 is applied to the input of "divide by 12" counter IC3. The input to IC3 is equivalent to 30 electrical degrees at 400Hz and the four outputs of IC3 divide the 350 electrical degrees into twelve 30 degree steps. These outputs are applied to the memory integrated circuit IC5 to inputs A4, A5, A6, and A7.

The VCO at IC2 terminals 5, 4, 12, and 9, 10, 7 is synchronized with the frequency control every 30 electrical degrees through transistor Q2 as described above. At full output voltage the VCO output frequency provides 15 pulses of 1 electrical degree every 30 electrical degrees and operates at a frequency of 72KHz or less. Voltage control is accomplished by counting to 15 faster and waiting for the synchronized signal from Q2 before starting the next 15 count. The 15 count is accomplished in IC5 and appears as feedback from output O4 on IC5 to input 10 of the VCO; when output O4 is low, the VCO discontinues operation until the synchronized signal enters at Q2.

Output of the VCO is counted on the second half of binary counter IC4, and the zero to 15 degree electrical signals are applied to Memory integrated circuit inputs A0, A1, A2, and A3.

Memory integrated circuit IC5, a 256x4 PROM, is programmed with the logic to generate wave shapes at outputs O1, O2, and O3 in the pattern shown on drawing 20580.

4.3 Driver Module - The schematic for the Driver Module is drawing 20001. Signal from the Logic & Control Module is split into an upper and lower output signal and time delayed (5 to 10 microseconds) at HEX inverters IC1 and IC2. IC2 is a Schmitt trigger. The lower time delayed signal is amplified by transistors Q8 and Q6 and applied to the lower power transistor. The time delay assures that an upper and lower transistor **do not** conduct simultaneously.

In order to assure rapid turn off, a signal without time delay is applied through capacitor C4 to transistor Q7. Transistor Q7 transmits the rapid turn off signal to transistor Q5, which generates a positive base signal to PNP transistor Q6 by causing the cathode rectifier CR10 and bias capacitor C3 to go positive to the potential at terminal M. Duration of the rapid turn off signal is 10 to 18 microseconds.

The upper driver amplifier and rapid turn off circuit work identically as the lower.

4.4 Output Power Module - Refer to drawing 20748, which is the schematic diagram of the power modules. Twelve of these modules are connected in a three phase bridge, four in each of the three legs. (See drawing 40466).

In each power module, two transistor gain stages are provided by Q1 and Q2. Rectifier CR1 supplies a path for reverse currents into the inductive load of the associated output transformer primary winding.

To assure rapid turn-off, isolated bias is connected to Q2 from rectifiers CR2 and CR3, filtered by C1.

Resistors R3 and R4, diode CR4 and capacitor C2 form a "snubber" network that prevents high voltage overshoots when transistor Q2 is turned off.

4.5 Phaselock Loop Module - Refer to the Phaselock Loop Schematic drawing 40183. The reference, or control phase enters the module at pins "R" and "S" and is converted to a square wave at pins 4, 5, and 12 of comparator IC1. Three Schmitt Trigger stages on IC2 apply the square wave to pin 1 of IC3, which is a phaselock loop integrated circuit. The reference signal is at pin 1 and the controlled or feedback signal at pin 3. Pins 2 and 13 produce a symetrical error signal.

In a similar manner, the voltage phase to be controlled enters the module at pins "F" and "L" to be changed to a square wave at IC1 terminals 7, 9, and 10. Schmitt triggers are used here as in the reference phase section.

The symetrical outputs from the phaselock loop integrated circuit IC3 are converted to a single output on amplifier terminals 1, 2, and 3, part of dual amplifier IC4. Output at terminal 1 is coupled to the second half of IC4, which contains the principal time constant in the feedback network for phaselock stability. Resistor R23 permits trimming of the zero phase condition or electing to operate at a phase other than zero.

Resistor divider R26 and R27 form a minimum voltage below which it is unsafe to operate the inverter. This voltage is auctioned with the amplifier output voltage at rectifiers CR3 and CR4.

SECTION 5. ALIGNMENT PROCEDURES

There is one adjustment in the power supply module for low voltage cutout and one adjustment of the Logic & Control Module for limit. Frequency and voltage are adjusted on the front panel.

5.1 Low Voltage Cutout - The low voltage cutout adjust R12 on drawing 20734 is factory set. If the Frequency Converter ceases operation and there is no blown fuse, check and reset R12 using the following procedures:

1. Disconnect the twelve output power modules.
2. Connect an oscilloscope to the 5V delay output and a digital VM to the 5V output.

   NOTE: Convenient measuring points are the negative terminal of C1 and the collector and emitter of Q1, all accessible with the power module installed.
3. Connect the input power through a three phase variac.
4. Apply power and raise input voltage to 120V line to neutral.
5. Check whether the 5V delay output is present; if not, adjust R12 to cause 5V delay signal to appear.
6. Reduce the input line voltage until the output 5V is 4.75V.
7. Adjust R12 so that the 5V delay voltage fully appears at this point.
8. Return input voltage to 120V.
9. Turn off the input voltage, then back on.
10. Confirm that the 5V delay appears at the output.
11. Remove the scope and DVM.
12. Re-connect the twelve output power modules.

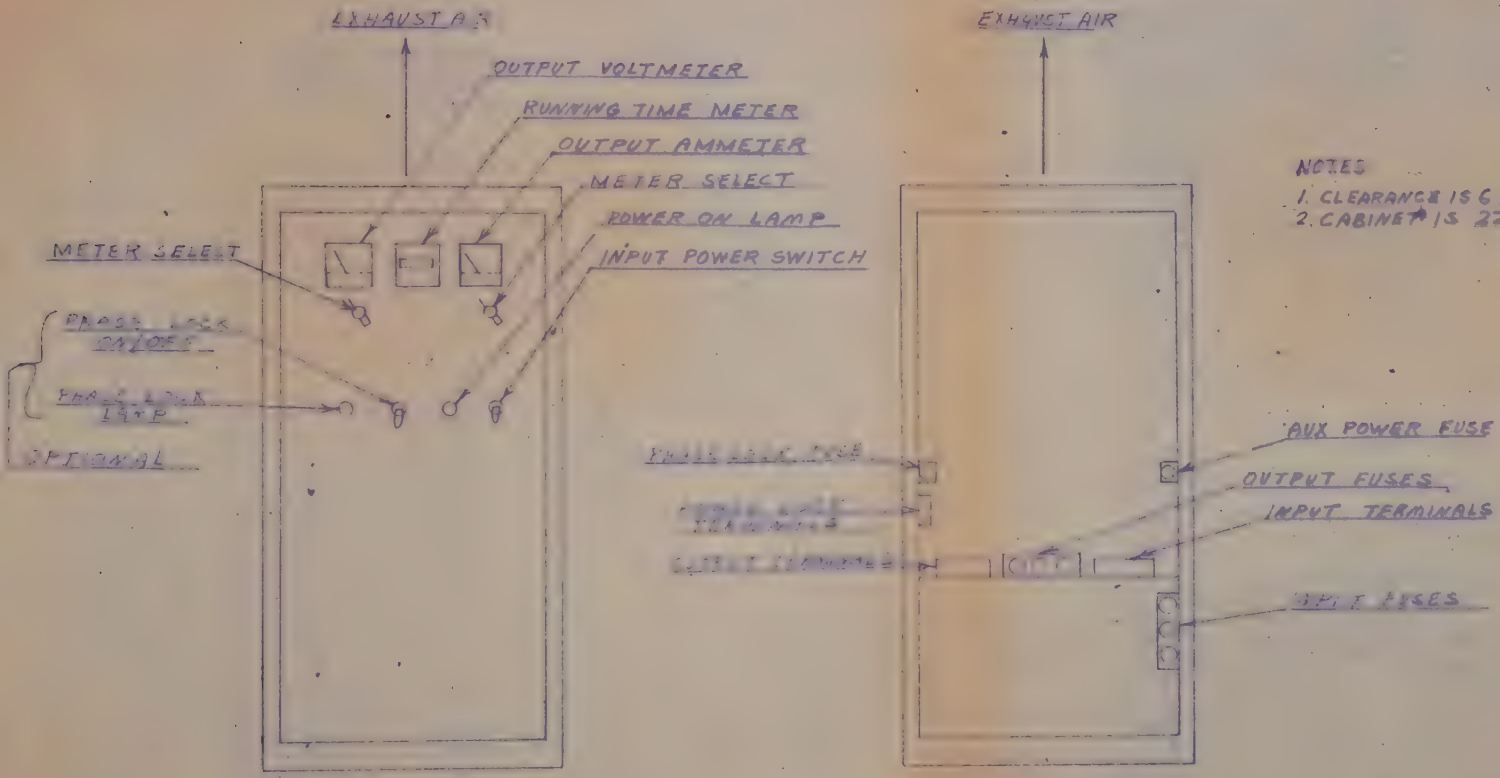
5.2 Current Limit Adjust - Current limit adjust requires use of dummy loads. Current limit is factory adjusted to 17.5 ± .5 amps. To reset to this value, apply a load of 6.5 ohms per phase, and adjust R8 (A20) for output of 90 volts per phase.

5.3 Phaselock Phase Adjust - Connect a phase meter to the reference signal and the output of the Frequency Converter and adjust R23 (A21) for zero phase shift.

SECTION 6. DRAWINGS

20785	Outline Drawing, Model 268-1-A-V-T-M-ET-PL Frequency Converter
40466	Schematic Diagram, Model 268-1-A-V-T-M-ET-PL, Frequency Converter
20748	Schematic, Power Module
20001	Schematic, Driver Module
20734	Schematic, Power Supply Module
40261	Schematic, Logic & Control Module
20580	Sinewave Synthesis, 400Hz
40183	Schematic, Phaselock Loop Module

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVAL

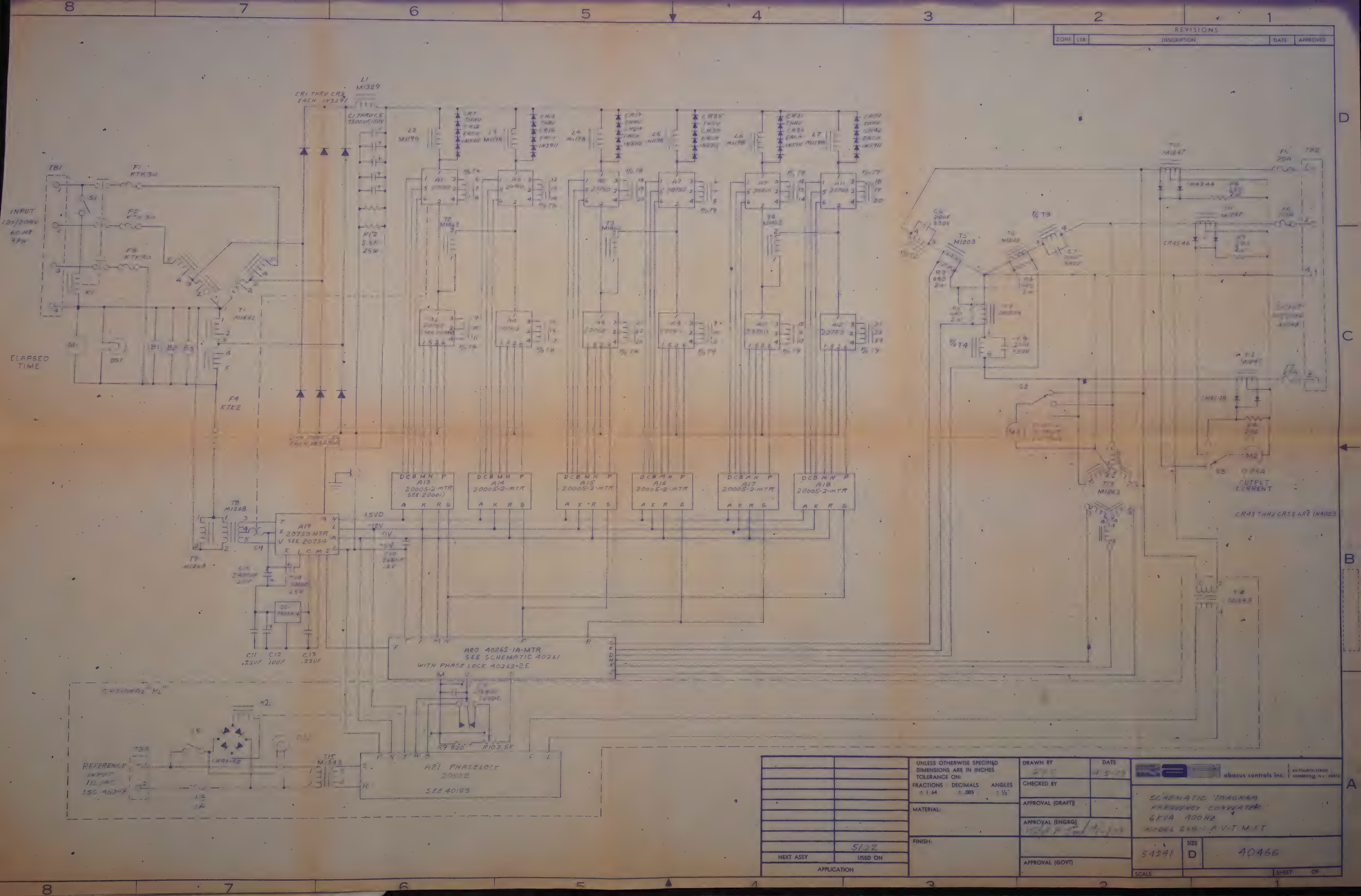


NOTES
1. CLEARANCE IS 6 INCHES, FRONT, REAR, TOP
2. CABINET IS 22 x 30 x 63 INCHES

		UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS ± 1/64 DECIMALS ± .005 ANGLES ±1 2°	DRAWN RPT 7/24/79	abacus controls inc. 80 READINGTON ROAD SOMERVILLE, N J 08876	
			CHECKED	OUTLINE DRAWING MODEL 268-I-A-V-T MET PL	
		MATERIAL	APPROVED		
		FINISH	APPROVED R P Conlon 7/27/79	SIZE B	54241 20785
NEXT ASSY.	USED ON			SCALE	SHEET
APPLICATION					

8	7	6	5	4	3	2	1

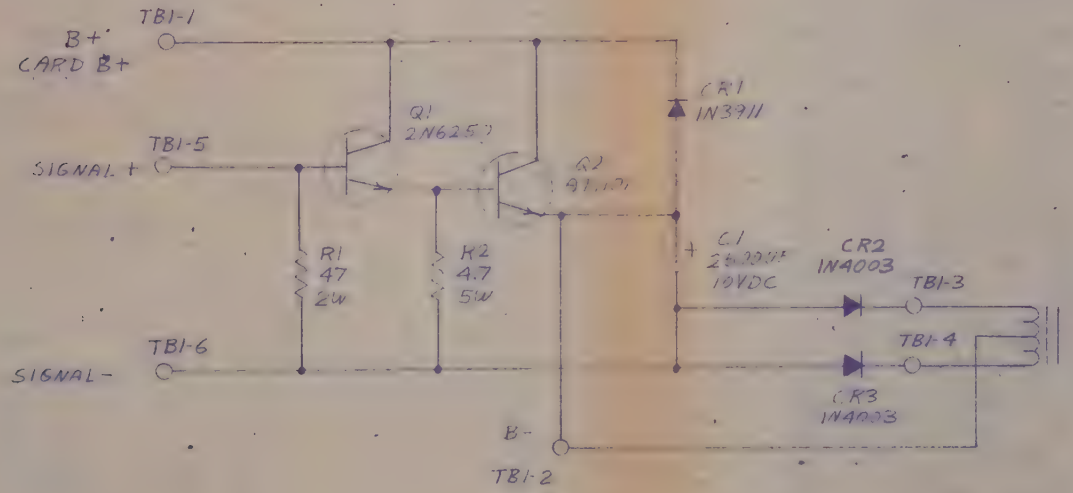
REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED



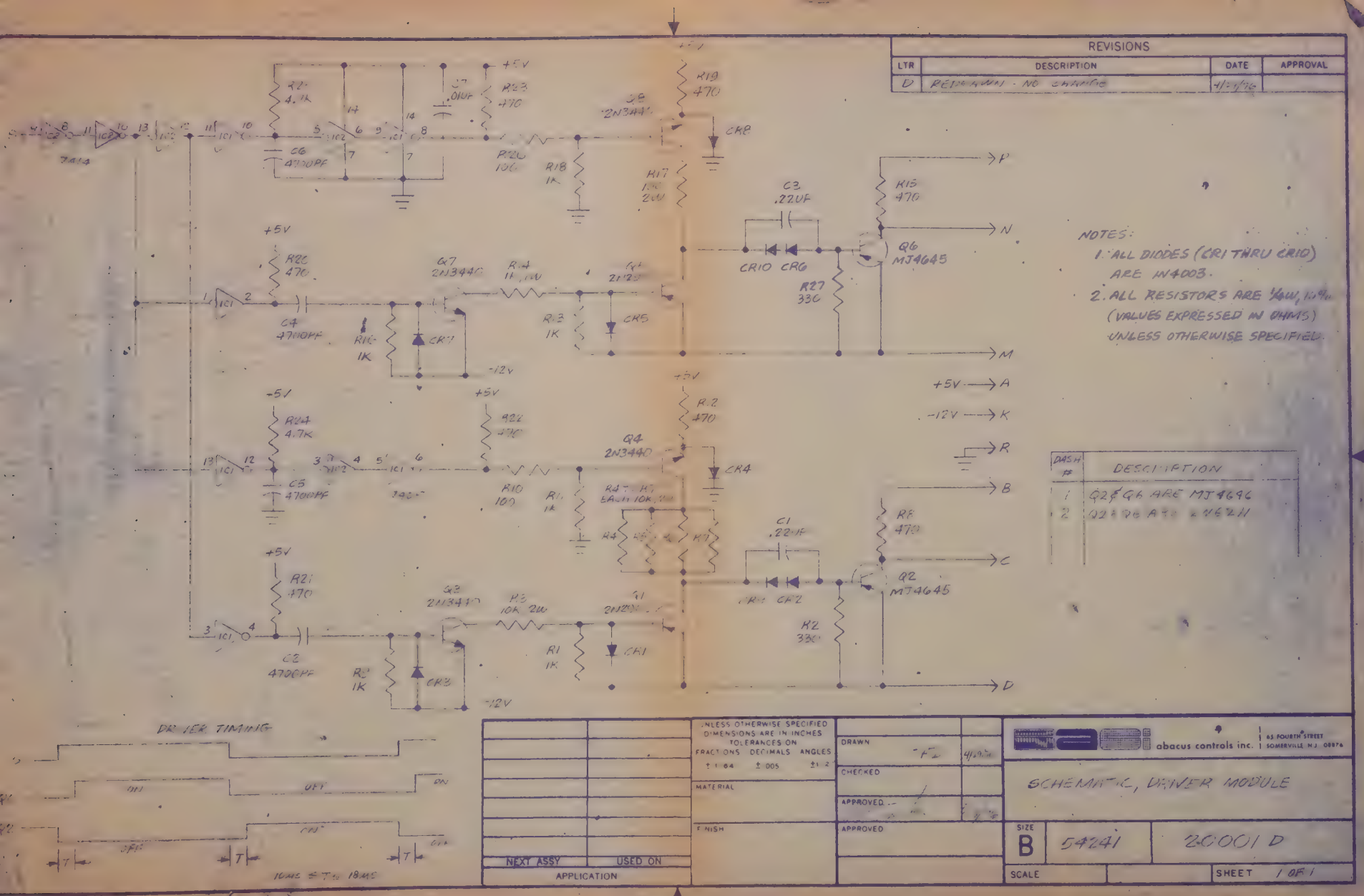
		UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCE ON: FRACTIONS ± 1/64 DECIMALS ± .005 ANGLES ± ½°	DRAWN BY	DATE 4-5-73	abacus controls inc. 65 FOURTH STREET SOMERVILLE, N.J. 08876
			CHECKED BY		SCHEMATIC DIAGRAM FREQUENCY CONVERTER 6 KVA 400 HZ MODEL 268-1 A-V-T M.E.T
		MATERIAL:	APPROVAL (DRAFT)		
			APPROVAL (ENGRG)		
	5122	FINISH:			54241 SIZE D 40466
NEXT ASSY	USED ON		APPROVAL (GOVT)		SCALE SHEET OF
APPLICATION					

8	7	6	5	4	3	2	1

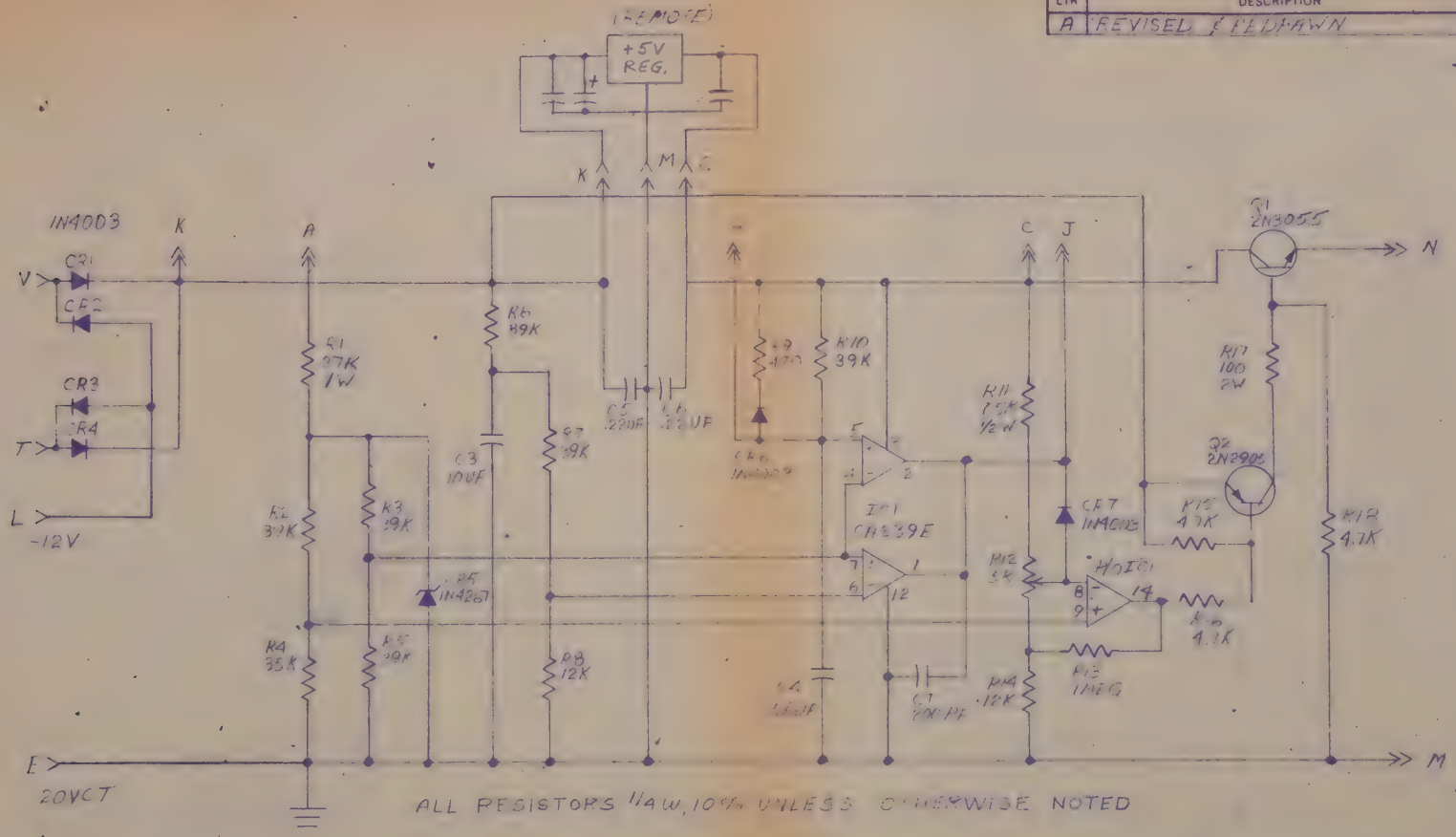
REVISIONS			
LTR	DESCRIPTION	DATE	APPROVAL



		UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS ±1/64 DECIMALS ±.005 ANGLES ±1°			abacus controls inc. 80 READINGTON ROAD SOMERVILLE N J 08876
			DRAWN RT	4/4/74	SCHEMATIC, POWER MODULE
		MATERIAL	CHECKED		
			APPROVED		
		FINISH	APPROVED		SIZE B 54241 20743
NEXT ASSY.	USED ON				SCALE SHEET
APPLICATION					


REVISIONS
LTR | DESCRIPTION | DATE | APPROVAL
D | REDRAWN - NO CHANGE | 4/2/76
NOTES:
1. ALL DIODES (CR1 THRU CR10) ARE IN4003.
2. ALL RESISTORS ARE ¼W, 10% (VALUES EXPRESSED IN OHMS) UNLESS OTHERWISE SPECIFIED.
DASH NO. | DESCRIPTION
1 | Q2 & Q6 ARE MJ4696
2 | Q2 & Q6 ARE 2N6211
+5V
-12V
A
K
R
B
C
D
M
N
P
DRIVER TIMING
ON
OFF
T = 10MS ± 1MS
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS ± 1/64 DECIMALS ± .005 ANGLES ± 1/2
MATERIAL
FINISH
NEXT ASSY
USED ON
APPLICATION
DRAWN
CHECKED
APPROVED
abacus controls inc.
65 FOURTH STREET SOMERVILLE NJ 08876
SCHEMATIC, DRIVER MODULE
SIZE B
54241
20001 D
SCALE
SHEET 1 OF 1

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVAL
A	REVISED & REDRAWN	9.16.76	V. Apps



ALL RESISTORS 1/4W, 10% UNLESS OTHERWISE NOTED

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON FRACTIONS ± 1/64 DECIMALS ± .005 ANGLES ± 1°

DRAWN LADD 2/21/77
CHECKED
APPROVED 2/21/77
APPROVED

MATERIAL
FINISH

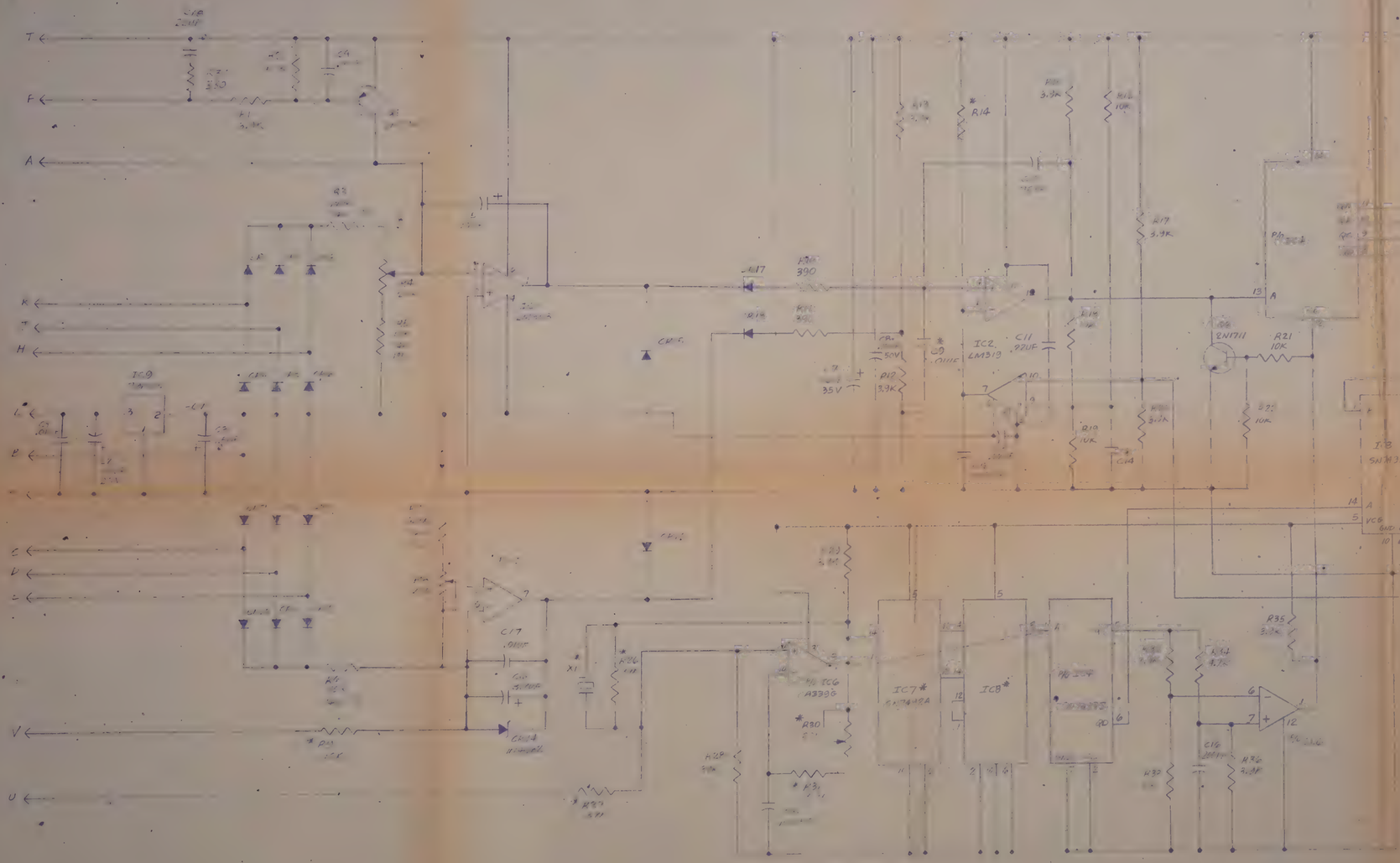
NEXT ASSY. | USED ON
APPLICATION

abacus controls inc.
80 READINGTON ROAD
SOMERVILLE, N. J. 08876

SCHEMATIC, POWER SUPPLY

SIZE B | 54241 | 20734
SCALE | SHEET

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APP
	A	ADDED C18-R37-C17		



1. [illegible]
2. * VALUE AND LOCATION DEPENDENT ON FREQUENCY AND CONTROL OPTIONS.
3. RESISTORS ARE IN OHMS, 1/4 WATT, 10% UNLESS.

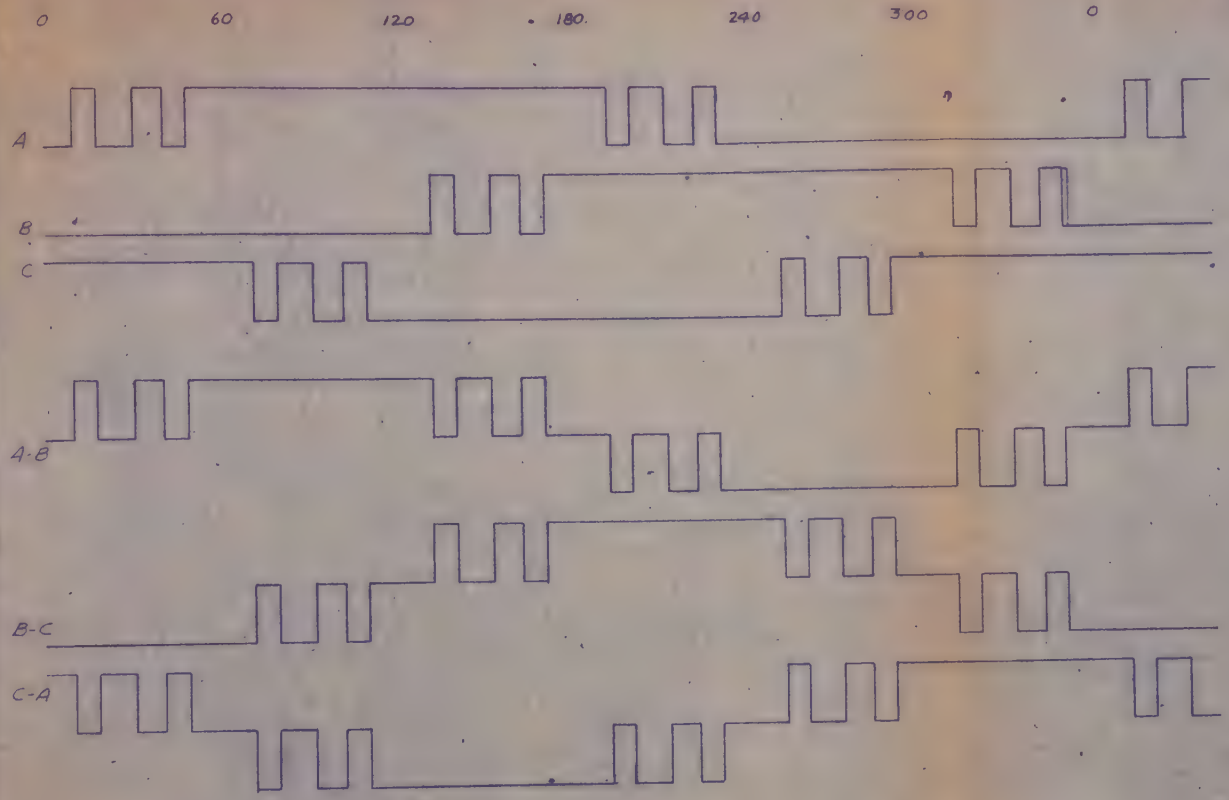
		UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCE ON: FRACTIONS ±1/64 DECIMALS ±.005 ANGLES ±1/2°	DRAWN BY	DATE
			CHECKED BY	
		MATERIAL:	APPROVAL (DRAFT)	
			APPROVAL (ENGRG) [illegible]	9-14-78
		FINISH:		
NEXT ASSY	USED ON		APPROVAL (GOVT)	
APPLICATION -				

abacus controls inc. | 63 FOURTH STREET SOMERVILLE, N.J. 08876

SCHEMATIC DIAGRAM
LOGIC & CONTROL MODULE

	SIZE	
57321	D	4[illegible]61
SCALE		SHEET OF

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVAL



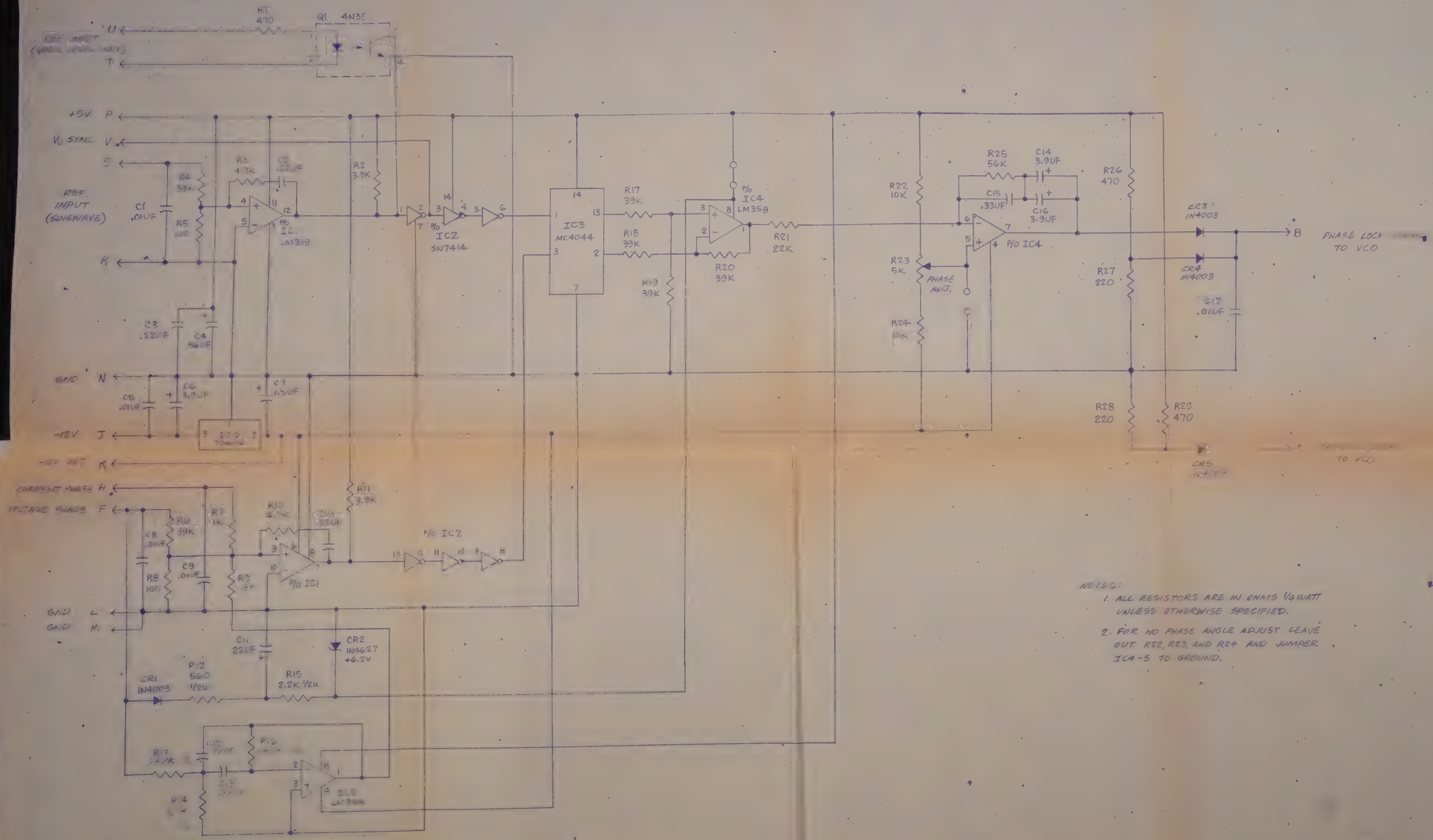
		UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS ±1/64 DECIMALS ±.005 ANGLES ±1/2°	DRAWN Perri 1-29-78
		MATERIAL	CHECKED
		FINISH	APPROVED
NEXT ASSY.	USED ON		APPROVED
APPLICATION			

abacus, controls inc. 65 FOURTH STREET SOMERVILLE N.J. 08876

SINEWAVE SYNTHESIS
400 HZ

SIZE		
B	54241	20580
SCALE		SHEET

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	ADDED PIN FUNCTIONS	8-8-77	



NOTES:

1. ALL RESISTORS ARE IN OHMS 1/4 WATT UNLESS OTHERWISE SPECIFIED.
2. FOR NO PHASE ANGLE ADJUST LEAVE OUT R22, R23, AND R24 AND JUMPER IC4-5 TO GROUND.

		UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCE ON: FRACTIONS ± 1/64 DECIMALS ± .005 ANGLES ± 1/2°	DRAWN BY	DATE
			CHECKED BY	
		MATERIAL:	APPROVAL (DRAFT)	
			APPROVAL (ENGRG)	
		FINISH:		
NEXT ASSY	USED ON		APPROVAL (GOVT)	
APPLICATION				

abacus controls inc. | 45 FOURTH STREET | SOMERVILLE N.J. 08876

SCHEMATIC, PHASE LOCK LOOP

54241 | SIZE D | 40183

SCALE | SHEET OF

abacus controls inc.

P.O. Box 893
SOMERVILLE, N.J. 08876
201-526-6010

ABACUS CONTROLS INC. - WARRANTY

Abacus Controls Inc. warrants each instrument manufactured by it to be free from defects in material and workmanship. Our liability under this warranty is limited to repairing or replacing any instrument or part thereof, except fuses and batteries, which shall, within one year after date of shipment to the original purchaser, be returned to us, in original cartons or equivalent, with transportation charges prepaid, prove after our examination to be thus defective. Our warranty for this instrument is rendered void if the unit has been abused or has been modified, unless such modifications have been made in accordance with written instructions received from Abacus Controls Inc. All returns must be authorized by Abacus Controls Inc. Repaired equipment will be returned prepaid to credit worthy customers with an invoice for transportation costs and repair charges if applicable.

Abacus Controls Inc. reserves the right to discontinue instruments without notice, and to make modifications in design at any time without incurring any obligation to make such modifications to instruments previously sold.

Abacus Controls Inc. shall not be liable for any operational delays or consequent damages under this warranty. There shall be no other obligation expressed or implied.